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# ILLUMINATING ENGINEERING SOCIETY

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CONTENTS

Page

Decorative Lighting, by L. H. Hubble *(Fellow)* - - - - - - 207

Department Store Lighting, Factors Influencing the Design, by Alan W. Jervis, Assoc. I.E.E. *(Member)* - 226

Fellowship - - - - - - 250

Register of Lighting Engineers - 250

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# Decorative Lighting*

By L. H. HUBBLE (*Fellow*)

**Summary**

Decorative lighting is not so much a practice in itself as an essential component of any lighting scheme. The word "decorative" is misleading in that it implies ornament, whereas, in point of fact, the decorative component of lighting may be only a matter of simplification; indeed, the modern tendency appears to be towards the avoidance of lighting "decoration" and the substitution of lighting harmony.

The paper contends that, approached in this way, decorative lighting can be analysed in a manner impossible if it were considered to be purely an artistic function. With the aid of such analysis, this aspect of illuminating engineering can be brought within the scope of a great number of lighting engineers who might otherwise feel unqualified to tackle those lighting problems in which decoration is of great importance.

The approach to the decorative component must take the form of a search for harmony, firstly in relation to the prevailing human emotion of those for whom the lighting is designed and secondly in relation to the architectural characteristics of the space under treatment.

The paper terminates with a detailed description of a particular installation, showing how the above reasoning was applied.

## Introduction

The term "Decorative Lighting" suggests the study of the practice of a particular branch of lighting; it implies that certain forms of lighting fall into this category, as distinct from other forms of lighting. Should such an interpretation be given to it, this paper would be limited to that somewhat sugary field of lighting employing festoons of coloured lamps along the foreshore, or to advertising signs. It might embrace effects in the home, such as the illumination of statuettes and bunches of flowers, and, by the same token, might include the dramatisation of an exclusive model in a hat shop.

For the purposes of this paper, however, the interpretation of Decorative Lighting is that part of any scheme of lighting which goes beyond its purely functional requirements and adds to, or by discreet handling does not detract from, such aesthetic qualities as are present in the space to be lit. This definition thus divides the subject into two parts, namely, additive and subtractive.

### Additive Factors

The additive side of the definition deals with functional lighting which can be improved by treatment; for example, in industrial and commercial applications where specular objects are being lighted it may be necessary to use a diffusing medium over the light sources. Functional lighting does not necessarily become decorative as a result, but it may do so in part if the lighting engineer has not restricted himself to the bare functional needs but has also related the appearance of the installation to its surroundings. Fig. 1 illustrates this in a simple form. A series of fittings could, from a purely functional point of view, give equally effective lighting; but the method adopted

* Manuscript received on December 30, 1947. Presented at a meeting of the Society held at Harrogate on June 17, 1948.

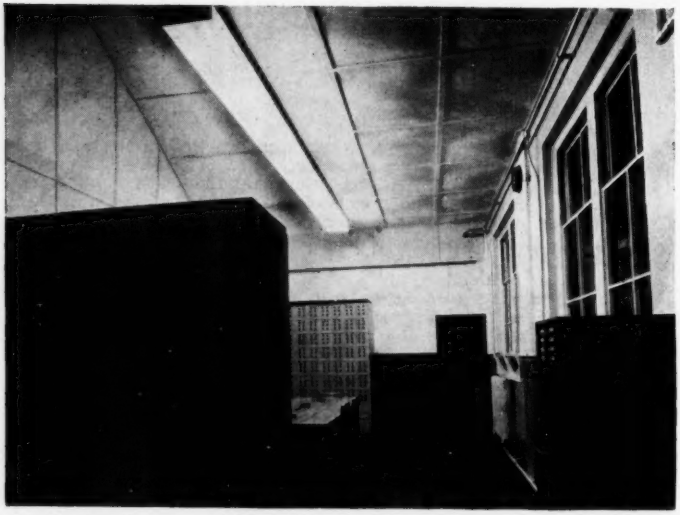
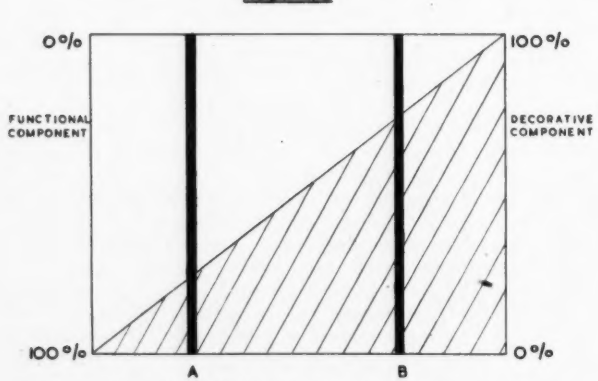


Fig. 1. Showing how the addition of a decorative component can take the form of simplification.

is definitely related to the simple, efficient, rectangular shape of the room, not only geometrically, but harmoniously. The fitting is some 21 ft. long, and is shrouded by four 5-ft. lengths of "Perspex," butted together. The complete absence of glazing bars is perhaps the keynote to the design.

It is not very profitable to attempt to evaluate the functional and decorative components of particular lighting installations, for these factors are essentially psychological; but it is necessary that the lighting engineer should have some clear understanding of the factors involved. Fig. 2 is an attempt to express




(A) Well-designed functional lighting. (B) Primarily decorative lighting.

Fig. 2. Showing decorative lighting as a component of any lighting scheme.

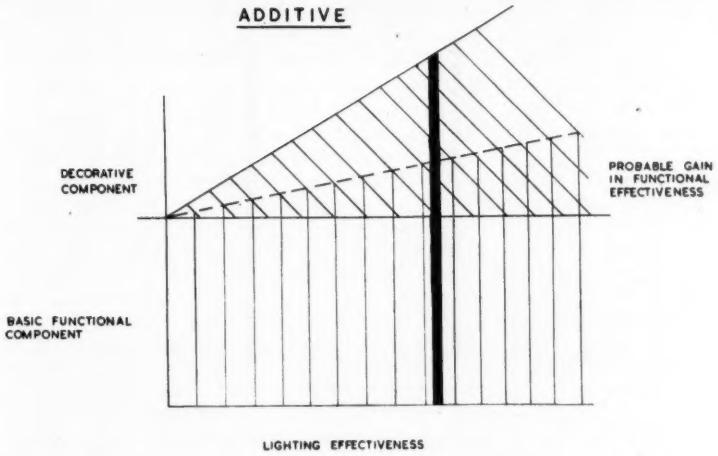


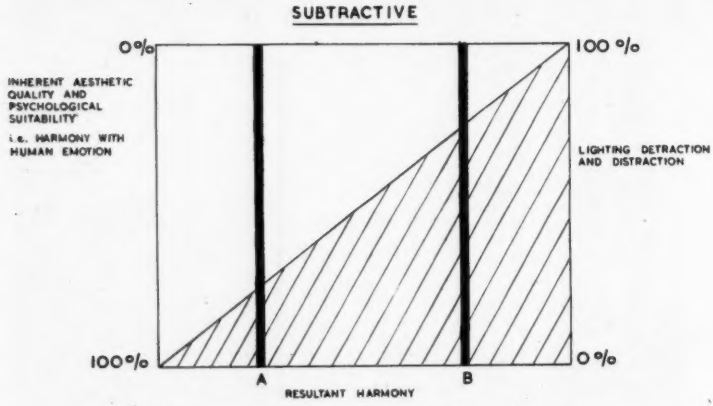

Fig. 3. Showing how the addition of a decorative component may increase the functional as well as the overall efficiency.

graphically the fact that all lighting must have a decorative component. Obviously, in purely industrial applications improved appearance of the fittings increases the decorative component. Alignment, neatness of installation, cleanliness, replacement of lamps that have grown dull with age, are all decorative components, and to some extent it may be assumed that care for the decorative side will automatically increase the functional components. Fig. 3 shows the added decorative component with probable gain in functional effectiveness.

**Subtractive Factors**

The subtractive part of this definition concerns the restraint needed lest the means of lighting should detract from inherent beauty, and offers perhaps the more subtle field of investigation in lighting practice. It raises the question as to whether traditional methods of lighting buildings of antiquity and architectural merit are in themselves a part of the architecture and should therefore be preserved; or whether such lighting equipment should be considered extraneous to the architecture, which implies that anything in good taste might be used without any greater offence than has already been committed. This controversial point will be discussed more fully later. There is, of course, no hard and fast line of demarcation between the additive and subtractive aspects, for they are components in almost any lighting scheme; but in Fig. 4 the subtractive graph uses entirely different factors, and assumes vital desiderata which, unless one is very careful, will be spoiled by any form of lighting. In fact, some architectural purists might say that, in certain instances, artificial lighting can only be applied at the expense of aesthetic quality.

This, then, is the subject matter of this paper, and the development of it is addressed to those who may hesitate to enter this field for fear of doing the wrong thing or from a paucity of ideas.




(A) A good compromise. (B) Thoughtless use of incongruous technique.

Fig. 4. Subtractive effect of lighting installations.

## Need For Training

By some freak of nature people are born who, as soon as they are physically capable, find themselves able to play a musical instrument. Some of the more gifted also have a highly developed musical sense, and can not only accurately reproduce complex music such as a Bach fugue by ear, but can create music of great beauty after the style of any composer whose works they happen to have heard. They may even show a particular tendency to revert to a style of their own, indicating pure musical genius. It is a great pity, however, that many of those so gifted can neither read a note of music, nor analyse and record their conceptions.

In that part of lighting which we describe as decorative, we find a certain number of people who have a flair comparable with that of the musical genius. However, just as it would be unfortunate if the ability to compose music were limited to those who did not have to learn the hard way, so it would be disastrous if we had to leave the decorative component of lighting to the few who are similarly gifted. Furthermore, although the musical genius may not need to commit his thoughts to paper, the lighting engineer has not only to describe his conception in illustrations, but he must convert his ideas into mechanical, electrical, architectural and other practical terms; in addition he must so design, that inexpert hands may maintain his handiwork in worthy condition.

Dr. Walsh in his recent presidential address* gave a formidable list of subjects in which a lighting engineer should endeavour to be proficient; he also emphasised the manysidedness of the lighting engineer's profession, and it would appear that the practice of the decorative side of lighting is the very epitome of that vocation. The subjects Dr. Walsh enumerated can all be learned; they are comparable with the theory of music which also can be learned by anybody so minded; but the questions are, whether the conception of decorative lighting can be learned, and whether people can be trained to do the right thing psychologically and aesthetically, as well as functionally. The author believes that to a large extent they can. Of course with all the training in the

* Trans. Illum. Eng. Soc. (Lond.), Vol. XII, No. 7, 1947, p. 149.

world one would not always get the same answer from different people, but their respective results might all be concordant.

### Relation Between Decorative Lighting and Human Emotion

The first essential of decorative lighting is that it shall be in harmony with the prevailing human emotion, and the first step, therefore, is to decide the atmosphere to create. Even in the lighting of an ordinary living room one is presented with a large choice of treatments in relation to the temperament of the occupant. It is obvious that the treatment for an elderly studious man would not be the same as for a busy family man; this difference would also be shown in the furnishings and colourings of the rooms in question.

The same concept applies when dealing with groups of people. Consider for example two groups of people bent on an evening's dancing, one a crowd of care-free holiday folk and the other more sophisticated, even a little *blasé* or bored. The collective emotions of these two groups will be different. The treatment for the one would be such as to promote gaiety with an abundance of coloured lighting, crystal balls, spotlights, and for the other perhaps only sufficient light to give glamorous emphasis to those who possess it and not enough to pierce the armour of the beauty parlour.

Another variation on the same theme may be illustrated with two shopkeepers, one intent on excluding from his clientele all but the wealthy, or as he might describe it, high class; and the other managing a chain store bent on displaying the greatest multiplicity of popular lines to the greatest number of people. In the first shop we find cornice, pelmet and other concealed soft lighting, with occasional models dramatised with a spot or local lighting; at the most we find discreetly louvred fittings arranged artistically about the premises. Soft carpets deaden the sound, assistants enunciate perfectly in uniform golden voices. The chain store, however, has space lighting, in this country perhaps 20 lumens per sq. ft., on the other side of the Atlantic perhaps 100. There are countless other instances of this "Collective Human" aspect; sometimes the lighting must meet an established need, sometimes it is used to attract the desired group.

The individuals and groups so far mentioned might be classed as free people, who can select their own environment; but a very large part of the lighting engineer's work deals with people who are not free, and who, though temperamentally different, are obliged to spend much of their time together under uniform conditions. For these one must look for the lowest common denominator.

The decorative component in industrial lighting has been dealt with in many papers, but let us consider the lighting of control rooms where instruments remotely control and record what is going on elsewhere, as in a power station, and see where the purely functional requirements may logically lead us.

The operators sitting at their desks are more or less surrounded by panels of meters and recording instruments, of indicator lights and circuit diagrams. Until recently the panels have been black, and many are still grey. There may be no windows in the room, and some form of air conditioning is general practice, providing air at constant temperature and humidity every hour of the day. Since at least five changes of air are required hourly the room will be kept as small as reasonably convenient, so there may be a false ceiling nicely rounded off to the fronts of the panels. This also provides space for the air ducting, and access to the backs of the panels without actual entry into the control room. Meter glasses are notoriously prone to reflections of the light sources, and the

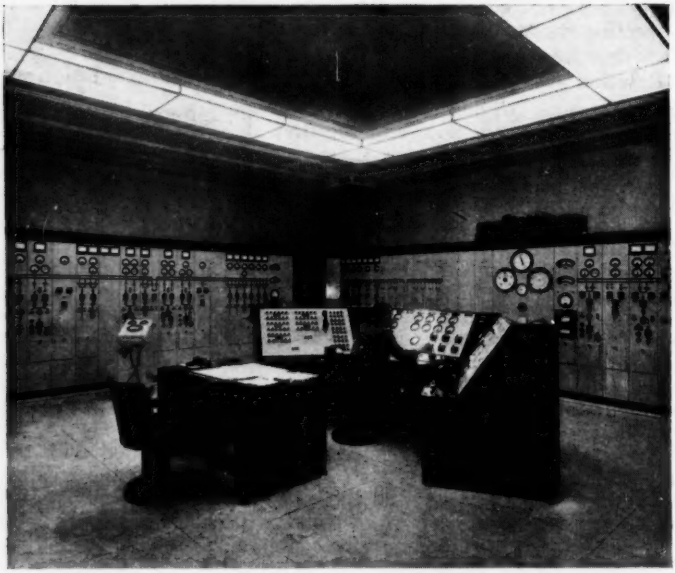


Fig. 5. Lighting of a Control Room.

tops of the panels and the rounded ceiling lend themselves to a system of indirect lighting.

One might be tempted to say that such a control room would be ideal since everything appears to be so absolutely right for the job. But is it? To the casual observer, undoubtedly yes; but it may be a different matter for those who have to live in it. It is quiet, there are no high lights, its smallness and detachment from the world are accentuated by the smooth moulding of wall to ceiling. The clock tells the hour, but not of day or night; no chill marks the dawn, no shaft of light shows the sun's zenith or its setting; no horizon tells the height or depth. It is a box of synthetic comfort as soulless as a coffin. Is it to be wondered that there are reports of doors being wedged open?

Fig. 5 shows a control room which started life on paper much as described above, the panels in which were to have been black. There are certain fundamental limitations which cannot be obviated, but something has been done. The switch panels are a cheerful shade of pastel green, the walls and ceiling are complementary with a peach hue, related to the use of daylight fluorescent lamps, to which reference is made later. The ceiling is extended to the limits of the building, so that when looking over the top of the panels a sense of distance is secured. The lighting is from a luminous-sided laylight of such shape and size as to obviate specular reflection as far as is possible with direct lighting. The glazing is of dewdrop glass, deliberately chosen to introduce some life and sparkle, rather than sandblasted, which is dead. The result is undoubtedly less functionally perfect, but at least it is a little more human.

The foregoing example may not meet with universal agreement, but is used to indicate the tremendous scope for the lighting engineer in applying the study of human emotion and reaction to his work. His subject may be of

the simplest character, such as tidying up some industrial installation, or it may be some vast piece of classical architecture. It may be the entrance to a block of offices, or a ballroom of a great ship. Whatever his subject he must first go straight to the end of it and endeavour to relate it to the prevailing human emotions. After considering other factors he must be able to visualise the finished article alive with people for whose pleasure he is applying his skill. He must see the gay, colourful crowds of the pavilion, the bustling anxious faces of the railway concourse, the detached concentration of the student in the library, the reverence of the congregation.

### Relating Artificial Lighting and Architecture

This is a subject full of contradictions. Firstly we have an inherent reverence for antiquity; secondly, we reverence and wish to enjoy the beauty of man's handiwork in stone and timber, in pigment and glass; thirdly, we are thrilled by and appreciative of the tremendous scientific developments of this age; and fourthly, we are ourselves, prejudiced, conservative, rebellious, or indifferent, encompassing every shade of understanding and ignorance. What a conglomeration of factors from which to extract a satisfactory compromise. Let us understand from the start that compromise there must be.

We practise our engineering art in an age largely devoted to bringing things up to date. This may be simple if confined to mechanical and purely functional developments, and there are many buildings in which lighting may be brought up to date without in any way giving offence architecturally. Many of these buildings are modern, and of predominantly functional architecture.

The more classical a building is, however, the more difficult the problem becomes, until it becomes almost entirely insolvable. Such a case arose in connection with the lighting of the "Black Friars" Monastery, at Canterbury, which was to be used for Christian Science meetings. The place is one of the sights of Canterbury, and although it appears to have little architectural merit except for some ordinary vaulting on the ground floor, added at a later period, it undoubtedly has great antiquity and, from the atmosphere of the place, a grim history. The room to be used for the meetings was about 80 ft. long by 30 ft. wide, and the stone and brick walls were capped by a steeply pitched roof, supported by closely spaced rafters in great variety of size. Every third or fourth rafter was tied across by simple tie beams, also of varying sections. The only evidence of lighting was some rough pointed iron brackets on the walls, obviously intended for primitive candles or torches.

The room was a recognised show-piece and as such, to be preserved. To put candle lamps on to the existing iron brackets, or to attempt to imitate them with electric or gas fittings would be entirely lacking in sincerity. To introduce pendant lanterns in imitation of a later period would be very nearly as bad, and might be regarded as perpetuating a ritualistic religion foreign to the tenets of Christian Science. To break right away and to introduce some purely functional light fittings such as opal glassware would be to create an architectural travesty. One might be permitted to add some architectural feature; for instance, if there were a convenient string course some distance from the eaves, one might have built it out into a cornice, and provided the lighting from this. In this room, however, there was no such string course and, in any case, the close and irregular rafters would reflect little light. The answer was, perhaps, to install light sources right up in the apex of the roof, depending on the louvring effect of the tie beams to prevent direct view of the lamps. In all things, however, one must be practical, and how to get up to service the lamps remains a problem.

There is no doubt that some traditional lighting fittings have become, by

association and because of their magnificence, a part of the architectural picture. A typical example is found in the Palace of Versailles, and it would be a bold man indeed who would dare to remove the great chandeliers which are known the world over and substitute something more modern, however much in good taste the alternative might be. However, the vast majority of lighting of this kind employs relatively insignificant equipment, such as the pendant fittings—ancient and modern—as used in churches, the parchment and silk contraptions employed in hotels, ballrooms, restaurants, and the like, or the ornamental glassware in pseudo-classical commercial buildings. Generally these fittings are not a part of the architecture, and many buildings would look far better without them.

### The Application of Extended Sources to Architecture

Fundamentally the lighting engineer is concerned with the substitution of new lighting for old, a process which becomes more interesting with the introduction of extended light sources. The modern fluorescent lamp has, of course, obvious advantages, such as its relatively high efficiency and its low brightness; but its shape and size are advantageous or disadvantageous according to how they are used in the search for harmony.

Fig. 6 shows a fitting resulting from this thought sequence. The church for which the fitting was designed is a very good example of early Gothic architecture, with a comparatively narrow nave and a lofty, low-pitched dark oak ceiling, the main beams of which are supported with braces terminating in stone corbels some distance down the walls between the clerestory windows. These clerestory windows provide the natural lighting, and, except for some occasional shafts of sunlight, are light sources of the usual cosine distribution, there being no external obstruction of the sky-line.

It appeared that it would be desirable to reproduce the daylight distribution, which provides sufficient light on the ceiling to display its beauty, while

Fig. 6. Special fluorescent lighting fitting in a church.

Fig. 7. The entrance hall of a publishing house in which the lighting enhances the tonal values of the woodwork.

still preserving the mystic atmosphere normally considered emotionally desirable. It was decided, therefore, to attempt to add something to the architecture which would harmonise with it, produce a similar light distribution, and at the same time use the most modern light sources. The design of the panel, with its three vertically burning lamps, is essentially Gothic in style, and the corbel at the bottom was copied from an existing ornament. The two 40-watt and one 80-watt lamps are held in position by a wooden projection of a design in keeping with the corbel. It is particularly emphasised that these three lamps were not in any way chosen to imitate candles or any other earlier form of lighting, but that they are permissible because they are in architectural harmony with the perpendicular motif and the vertical lines of candles, organ pipes, and reeded columns. A mistake was made in staining the wood to tone with the roof timber, and this lighting feature would undoubtedly have been

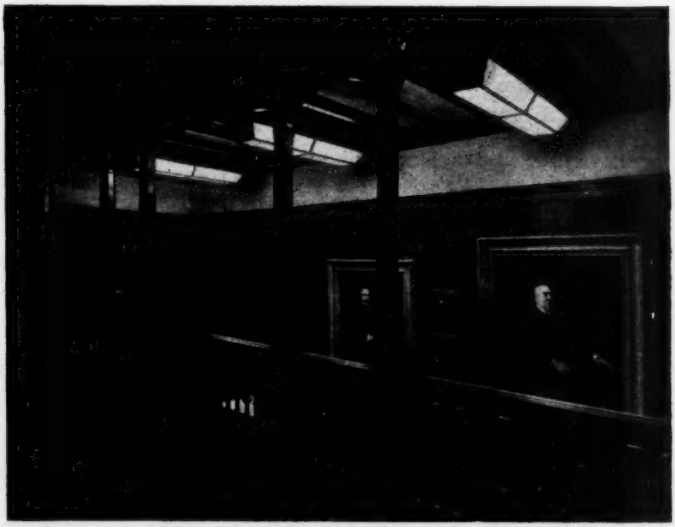


Fig. 8. Fluorescent lighting with wooden fittings designed to harmonise with the architecture.

Fig. 9. Lighting in a vestibule in which the architectural environment has been preserved.

better had it been finished to blend with the stonework to which it is applied.

It is not claimed that this particular experiment was successful, and it is mentioned here merely to illustrate a train of thought which was undoubtedly on the right lines, and which, with modifications to suit the buildings to which they are applied, may provide a sincere method of lighting churches with fluorescent lamps.

Fig. 7 is another example deriving from the same thought sequence. It is the reception hall and associated rooms of a famous firm of publishers; the human quality is that of "dignified cultural efficiency," while the architectural quality is such as to blend with the wood panelling, bookcases and general furnishings. These fittings are all made of wood, and the mouldings are repeated from those of the bookcases, etc. (Fig. 8.)

Fig. 9 shows the entrance vestibule to an imposing block of offices of somewhat classical design; the architecture is Ionic in ornamentation, but is not altogether true to style. The human quality required for this site is "commercial dignity." Architecturally no ready solution could be found by any form of pendant fitting or attachment, a compromise was obviously necessary, and advantage was taken of a comparatively deep recess in the entablature to install unbroken luminous panels which protrude in rectangular section from the recess. The various views of this installation show that except for increasing the brightness of these plain surfaces little change has been made to the architectural form; in fact, if one were to draw this vestibule, one would be compelled to draw almost the same longitudinal lines to illustrate the entablature with or without the applied lighting. Here, again, the complete absence of glazing bars is the keynote of the design. If glazing bars were introduced the whole horizontal motif of the lighting would be lost, and it would be turned into a series of fittings.

### Focal Point

Every interior should, if possible, have a focal point, the simplest example being the fireplace in any room. It does not matter whether the fire is lit or not, since the room is automatically furnished round the fireplace, which is frequently

emphasised with a picture or some other ornament. A room without a focal point lacks intimacy and meaning.

It is thus interesting to note the effect of the single fitting on the centre line over the bust at the top of the stairs in Fig. 9. Although the corridor which this fitting lights is transverse, the longitudinal arrangement of the fitting seems to give transverse emphasis at that point, at the same time maintaining and accentuating the longitudinal sense promoted by the lighting in the vestibule proper. The bust at the head of the stairs is the obvious focal point, but it was agreed that to over-emphasise this bronze would not be in good taste: hence, at the focal point, the lighting is rather subdued.

The reverse view, Fig. 10, shows how advantage is taken of an arch formed over the doorway to complete the functional aspect of the lighting by maintaining a ceiling brightness where it would otherwise fall off, and to emphasise

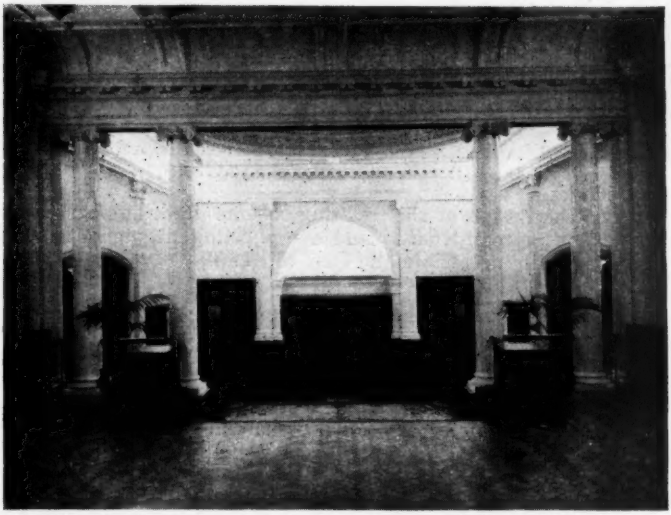


Fig. 10. Architectural emphasis in the entrance vestibule of a block of offices.

quietly the entrance to the building. A similar arrangement is repeated on the other side of the door in the outer vestibule, and with two applied indirect cornices on the flank walls provides a relatively low illumination to assist dark adaptation, no bright source being visible from without.

## A Detailed Example

In giving examples of the application of fluorescent lighting to classical or pseudo-classical architecture there is not only the conception of the idea, but the functional and practical sides of the design to be considered. It is of interest to go through one particular installation in its entirety in order to show what is involved and to emphasise that such installations make demands upon every branch of the lighting engineer's knowledge and experience. The installation chosen comprises the main lounge, staircase, balcony, ground floor corridors, entrance hall and ballroom of a large hotel.

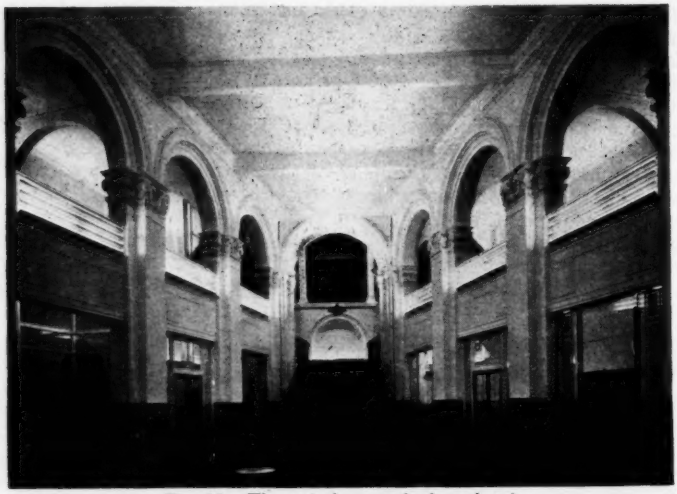


Fig. 11. The main lounge of a large hotel.

**Maintenance**

Throughout the design of this lighting scheme great emphasis was placed upon the question of maintenance and every fitting throughout the building has been made readily accessible and easy to clean.

**Conception**

The main lounge, Fig. 11, is, in shape, a sector of a circle, in the apex of which is a grand staircase leading up to a half landing from which the stairs continue to the right and left. Beyond the staircase are two galleries and the roof is supported by two classical columns. Surrounding the lounge at first-floor level are corridors used as additional lounge space away from the general activity below, and essentially quieter emotionally than the ground floor. The staircase is the focal point of the room, both emotionally and geometrically. It is reminiscent of many stage sets and the first point in conception is obviously to emphasise the staircase and the people using it.

The ground floor is the main concourse of the hotel and is used both by residents and as a general meeting place, and the atmosphere to be created is not that of pure relaxation, but a combination of relaxation and activity. Architecturally this room has marked vertical lines, coupled with horizontal lines provided by a solid balustrade and string. To adopt pendant lighting, however well done, would cause distraction emotionally and architecturally. Similarly, the pilasters with their ornamentation are such marked features of the architecture that to apply vertical lighting would be equally undesirable. It was decided, therefore, to create a luminous girdle right round the balustrade, this girdle to provide totally indirect lighting except that, being in four courses, the underside of the reflectors would be lit by the lamps below and these reflectors were, therefore, to be lacquered to an appropriate tone. The comparatively low brightness of this girdle neither adds to nor detracts from the architectural line, but by virtue of the shape of the room, increases the focal value of the staircase. This is, of course, due to the accentuated perspective resulting from the taper of the room towards the staircase.

The ceiling is approximately 30 ft. high, with a flat roof above it, but above

the staircase landing the ceiling is another 15 ft. higher, and there is a large window opening on to the flat roof. In order to emphasise the staircase fully it was decided to keep the galleries beyond at a much lower level of brightness, and pelmet lighting was designed to give direct lighting on to the landing and to bring out in strong contrast the two classical columns supporting the upper roof.

**Mechanical and Electrical Design**

Fig. 12 shows a section of the girdle fittings, each of which has four courses of anodised aluminium troughing 9 ft. long. As the distances between the pilasters vary from 9 ft. 4 ins. to approximately 11 ft., the ends are filled in by wooden panels fabricated on site to fit. The control gear is housed in removable trays in the top of the fitting, and a wooden sill is fitted on top of each unit and finished to match the mahogany hand-rail of the balustrade. Each fitting contains four 80-watt lamps and four 40-watt lamps, the lampholders protruding beyond the fitting at each end and concealed by the wood panels. The whole fitting is self-supporting in one piece on an angle framework, the reflectors being supported and their profile maintained by aluminium castings. The wiring is arranged so that two courses may be switched on independently and, to simplify removal for overhaul, each is provided with two plugs and sockets. The complete fitting stands on the existing sill, located by two dowels at the bottom and bolted back to the balustrade at the top.

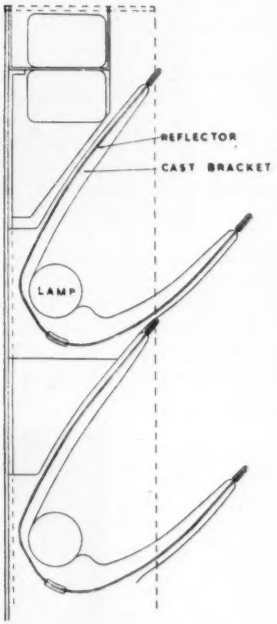



Fig. 12. Section of a girdle fitting.

**Colour**

Probably the greatest problem in the use of fluorescent lighting in such domestic interiors arises from the fact that the spectral distribution of the light from fluorescent lamps is not the same as from tungsten lamps and so tends to distort colours when compared with more traditional artificial lighting. It was essential, therefore, to ensure that guests, particularly women, should be satisfied as to their appearance when descending the stairs into the lounge, having "made-up" under tungsten lighting in their bedrooms. Some form of colour filter was therefore essential; and since this lighting was to be totally indirect, it was imperative that the lighting engineer also became responsible for the choice of colours in the decoration, particularly of the ceiling. Experiments were carried out using indirect lighting and various coloured panels until the subjects were satisfied with their appearance. The colour so chosen was in effect a pale vermilion, although vermilion was not used because it tends to fade. A mixture of scarlet and chrome orange, the latter having the effect of removing the "blueness" from scarlet, was found satisfactory. As a general principle it cannot be over-emphasised that when using fluorescent lamps one must use decorations in which there is a degree of "warmth," not only because the fluorescent lamp is deficient in "red" as compared with day-

light and unduly strong in "green," but also because, traditionally, artificial lighting, be it gas or tungsten, is predominantly "red" and automatically adds warmth to decorations in which "red" is not strongly present.

The visible parts of the girdle reflectors are first sprayed with a phosphor bronze metallic lacquer over which is sprayed a coat of transparent scarlet lacquer. The result is to give a translucent effect which appears to remove the weight of these fittings.

In lighting the staircase, thought was given to the wearing of jewellery, which looks very ineffective under diffused forms of lighting and two 300-watt tungsten spotlights were therefore placed vertically above the landing to give the necessary life and sparkle to jewellery, sequins, and the like.

**Balcony**

On the balcony itself the more subdued emotional effect was produced by a series of applied cornices, the ceiling again being pink, and Fig. 13 shows the very pleasant cloistering effect and restful atmosphere which results. In order to conform with the general character of the lighting and maintain the architectural simplicity all the surrounding ground floor corridors and the entrance vestibule are lighted indirectly by applying a cornice to the bottom of the bressummers over the lounge windows.

In the design of these corridor cornices it was obvious that these bressummers were not solid, but were merely very deep plaster casings around the first floor rolled-steel joists: hence, although a very small load could be placed on this plaster casing, the cornices themselves had to be as far as possible self-supporting from end to end. A knowledge of the structure of a building is essential if satisfactory equipment of this kind is to be manufactured elsewhere from drawings and to be fitted on site by electrical contractors. The inconvenience and cost of having to call in other trades in order to make it possible

Fig. 13. A balcony corridor in a large hotel.

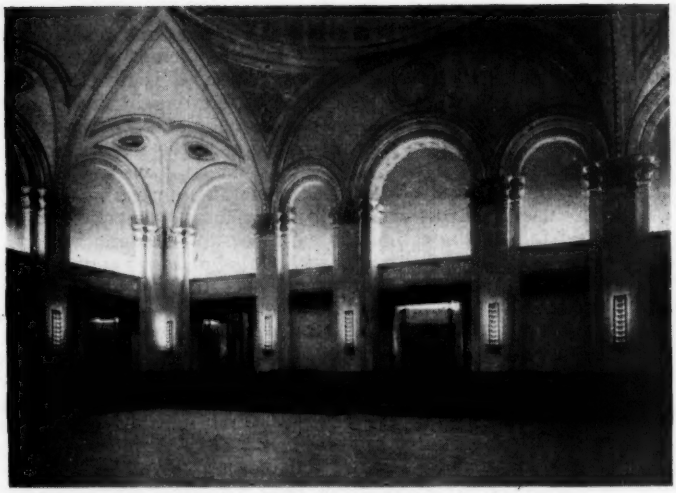


Fig. 14. The ballroom of a large hotel.

to support the lighting equipment is a measure of the lighting engineer's inefficiency in this respect.

**The Ballroom**

This ballroom (Fig. 14) is essentially for summer seasonal use and it was therefore decided that a rather more carefree and gay atmosphere was desirable than is usually required for a more sophisticated clientele.

Architecturally, however, the ornate vaulted ceiling which culminates in a dome appeared to call for a continuance of indirect lighting, particularly owing to the happy presence of a string course running right round the room except where broken by the pilasters. It was to add nothing to the architecture to add one small moulding to the top of this string course, and this provided a continuous band of indirect cornice lighting housing two rows of lamps, broken only by the pilasters. The ceiling itself was again coloured in a pinkish hue and the ornamentation picked out in silver. This was a bold step on the part of the decorators but has proved extremely effective.

Architecturally the pilasters should have been left bare, but in view of the emotional aspect it was decided that a vertical motif should be applied to break up the severity of the treatment so far described. Wall fittings were therefore designed in which a 40-watt fluorescent lamp is threaded up through a series of trumpet-shaped aluminium cups, the outsides of which are sprayed in a bronze lacquer and over-sprayed with scarlet, using a deep concentration around the upper lip. These fittings are almost totally indirect in their operation, and are of a low order of brightness, but the reflection of the lamp from below on the underside of each cup renders the whole fitting almost ethereal, and it is hard to believe that it is not made of translucent material.

**Calculations**

The more lighting methods depart from standard the more difficult it becomes to give accurate predictions of results in terms of illumination, but

good approximations are fairly readily obtainable. The co-efficients of utilisation published in the G.E. Handbook are very comprehensive, and by interpolation, they may be applied to most cases. Since co-efficients of utilisation are a function of distribution, room size and decoration, it is necessary to ascertain the light distribution of any given piece of equipment, and a prototype or "mock-up" of the fitting to be used should be made and a polar curve taken. This is not an elaborate job since it is the shape of curve that is required, and not the absolute values.

The girdle fitting previously described forms an interesting example of a method frequently used. It was desired to know what proportion of the total lamp output would fall on the ceiling, so a "mock-up" was made of one lamp in one reflector. A protractor was attached about the lamp's centre. A simple light meter was swung round the longitudinal axis of the lamp—on a piece of string some 6 ft. long—and readings taken every 10 deg. The lamp was then taken out, placed against a black background, and another reading taken. The polar curves were then drawn on squared paper and their areas integrated. This method gave a good enough idea of the efficiency of the fitting, actually about 55 per cent., and then by taking the angle subtended by the ceiling on the polar curve of the fitting, it was again a simple matter to integrate the polar curve between these angular limits. The profile of the reflector is such that nearly all the light does fall on the ceiling, or about 50 per cent. of the lamp light output. A further 5 per cent. loss was allowed because the visible parts of the reflectors were to be lacquered, although as these surfaces are nearly tangential to the light rays, only a small drop was expected. This gave 45 per cent. of the lamp output reaching the ceiling, and with 44 80-watt lamps at 3,000 lumens each, and 44 40-watt lamps at 1,600 lumens each, a total of 202,400 "ceiling" lumens was predicted. The area of the ceiling being 1,890 ft.$^2$, the average illumination ($F_C$) became 48.8 lumens per sq. ft.

Assuming a perfectly diffusing ceiling of 100 per cent. reflection factor, the ceiling brightness ($B_C$) becomes 48.8 ft. lamberts.

Now for a disc source of brightness B (foot-lamberts)

$$E \text{ (lumens per sq. ft.)} = B \sin^2 \phi \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(i)}$$

where $\phi$ is the half-angle subtended by the disc at a test point opposite its centre. As an acceptable approximation, any reasonable ceiling may be treated as a circle, and thus the area was treated as circular and angle $\phi$ determined. This gave the illumination on the test point, E, as 19 lumens per sq. ft. The choice of ceiling colour had yet to be determined, but as 10 f.c. maximum was the objective, it was possible to go as low as 65 per cent. reflectivity with a maintenance factor of .8, and this was reasonable as a pale red pigment was to be used in conjunction with a predominantly green lamp, and the reflector efficiency would be materially decreased with even a little dust.

Given radius of effective ceiling disc = 24.6′, and height = 30′.

$$E = B \sin^2 \phi \times 0.65 \times 0.8 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(ii)}$$

$$= 48.8 \times \frac{r^2}{r^2 + h^2} \times .65 \times .8$$

$$= 48.5 \times \frac{600}{1500} \times .65 \times .8$$

$$= 10 \text{ lumens per sq. ft.}$$

Working backwards from this, a C.U. of .094 is derived, and taking the G.E. Handbook and interpolating for all the known factors, a C.U. of .095 was

selected, showing a remarkable agreement of result from theoretical and empirical methods. Readings taken after some hundreds of hours gave an almost uniform 10 lumens per sq. ft.

**Reflector Design**

Those not normally engaged on reflector design may wonder how a reflector with such a narrow opening can be made giving more than 50 per cent. light output when designing around a lamp of such large source dimensions; the method employed may prove of interest. The 40-watt fluorescent lamp is opaque to its own light, and therefore it is necessary to ensure that the reflector profile always directs the light clear of the lamp itself. If the reflector is so designed that it is always normal to the tangent of the lamp, any element of light from a point on the surface of the lamp inside the tangent will be directed outside the tangent. The curve so described is an involute, that is, the locus of a point at the end of a line rolled round a circle. If the reflector approximates to this curve until it gets clear of the lamp, the remainder of the reflector may be designed as from a line source. This was the basis of the design of the girdle reflectors, and their comparatively high efficiency was the result. The reflectors were not entirely specular; were they so, a much higher efficiency would undoubtedly be achieved.

## Conclusion

No apology is offered for introducing some technical aspects of decorative lighting since it is the object of this paper to show that decorative lighting, far from being the prerogative of the artist, is indeed, as stated earlier, the very epitome of the lighting engineer's vocation; and that he practises a subject which is highly complex and worthy of higher appreciation than it generally receives. We have left behind the days when a lighting engineer was little more than a fittings salesman, and this paper suggests that by careful analysis it may be possible for the lighting engineer to bridge the gap between the few who have a flair for pure conception and the engineer who deals with the more technical aspects.

There may be many points of disagreement with what is contained in this paper, but its object is not so much to postulate theory or to state fact as to show the reason and need for the educational programme which our Society is encouraging and which our President so fully elaborated for the lighting engineer of the future.

Finally, let us not hesitate to add a decorative component to whatever lighting work we may be doing, and let us take as our guide the thoughts that, first and foremost, we are dealing with human emotion, and that our object should be to merge our necessary lighting equipment into the general picture, avoiding incongruity and insincerity.

## Discussion

Mr. W. R. Stevens said that he believed the paper to be of value because it stated that an engineer was not necessarily lacking in artistic sense. There was no reason to suppose that this sense was less inherent in the engineer than in any other member of the community: and proper training, while it may not produce the great artist, might well encourage competent work. There have been only a few great painters, and the world would be poorer if it were deprived of the many works of lesser merit. The engineer might also feel a little less diffident about his abilities if he recalled that Leonardo da Vinci was both a great artist and a great engineer. Again, much of the great architecture of the last century was due not to professed architects but to engineers.

Mr. Hubble was concerned to develop the sense of beauty in lighting, and

he took as his starting point the emotions of those for whom the installation is designed. This seemed a very reasonable basis. The characteristics of the users might be shown by their activities—for example, the dancing groups mentioned in the text—or by the architecture of the building. We were not able to put numerical values to these human characteristics and emotions, but they were no less important than such things as brightness and illumination which we could measure.

It was interesting to note that a book had recently been published in the U.S.A.* which developed the same theme of the relation between people and light. But it went much further than Mr. Hubble in attempting to find correlations, and was written in a style which did not commend it to engineers.

MR. W. D. SINCLAIR, commenting on the references that had been made to the architect, the musician, and the artist, said that the artist had to please himself, but the lighting engineer was trained to please somebody else. He did not think we should make great progress until we arrived at the stage when it was possible to measure beauty or quality. Was the author able to do that?

MR. L. J. DAVIES, remarking that he did not consider the architect could be regarded as an artist, said it was necessary to bring in the lighting engineer to show up the beauties of architecture, and flood lighting was the best means to that end. That applied particularly to ceilings.

MR. F. C. TYRRELL asked whether the author considered, from the experiments he had carried out, that any other than indirect lighting would avoid bad reflections on the glass of instrument panels.

MR. S. D. LAY said that one of the most difficult problems in lighting existing interiors was to select the best height for the light sources. If mounted on the ceiling, this was dark in contrast to the bright fittings, whilst if they were lower the effect was marred by the reversal of shadows from mouldings. Could Mr. Hubble indicate any approach to this problem?

Mr. Lay agreed with the author that a very even brightness distribution was psychologically unsettling. He had found that the provision of the focal point necessary for visual comfort was most difficult to achieve in industrial interiors and would welcome Mr. Hubble's comments on this point.

MR. F. M. WOOD remarked that all the instances mentioned by the author related to cases where money was apparently no object. Unfortunately there were many cases where money was an object, and therefore some information on the manner in which the poorer type of job would be dealt with would be interesting.

MR. HOWARD LONG (*contributed*):—

This paper is refreshing in introducing technical views between the old conception of decorative lighting and utility lighting. In such installations it is often found that insufficient attention is given to consideration of installation wiring and maintenance of the equipment, and to the requirements for the provision of good seeing conditions. Particularly in cases where there is a visual task to be performed, in an endeavour to produce a good general effect the fact that the provision of light is for the facilitation of seeing is often overlooked. Combination of these two requirements successfully to satisfy both

* Lighting to Stimulate People—J. Lloyd Kamm. Christopher Publishing House, Boston.

is often a difficult task and calls for much ingenuity and experience. Frequently, also, the efficiency of such an installation in the production of illumination is entirely disregarded.

In the paragraph headed "Reflector Design," at the end of the paper, a description of the contour adjacent to the lamp is given for a specific design. Whilst by this method the light is not thrown back on to the lamp over quite a wide angular zone, it must be thrown back on to the reflector, a point which is not noted.

MR. HUBBLE, replying to the discussion, said he had not attempted in the paper to indicate in any way what was good taste. All he did was to demonstrate, through examples, what should be the guiding principles. That was the most he could contribute.

In reply to Mr. Sinclair's point as to whether he could measure beauty or quality, he said that of course he could not, and he would not attempt to. All one could do was to determine in one's own mind how much damage one could do, and then try and be careful not to do it.

With regard to Mr. Davies's mention of flood-lighting ceilings, it would be found that in many buildings the mouldings and ornamentation of the ceilings were very heavily emphasised where the ceiling was poorly lighted from the windows. For that reason it was contentious whether the best means of artificial lighting was by floodlighting, since this would in many cases produce over-emphasis, especially where the carvings were particularly deep. Floodlighting might also destroy the emotional factor around which the building was designed.

In reply to Mr. Tyrrell on the question of instrument panel reflections, he fully appreciated the difficulties and dangers that could be run into in using direct lighting in control rooms. In the control room illustrated the lantern was so big, 19 ft. long, 14 ft. wide, and 3 ft. in sectional width, that there was literally no specular reflection.

With regard to reversal of shadows, he said he realised the difficulties in that connection, and that was why he did not think indirect lighting was ever the first choice.

As to the focal point in an industrial establishment, perhaps that would best be the manager's office!

Replying to the point concerning low cost jobs, he said it did not cost a lot of money to do some of these things.

Mr. Long's opening remarks were fully appreciated, and the question of efficiency must certainly not be overlooked. But what is the measure of efficiency? Surely lighting can only be evaluated in terms of effectiveness in all its aspects, and whereas in certain fields we can expect a range of C.U.s from, say, .45 to .65, in other fields a truly effective scheme might be considered efficient at a C.U. of . 2 or less. Colour filters, either direct or by means of coloured decoration, would reduce the C.U. considerably, but without them some lighting would be far less efficient in its ability to please.

With regard to the reflector design referred to in the text, the limitations were "cut off" and available width of opening, but within those limits it was possible to design substantially to the law propounded. The principal reasons for including this in the text was to bring out the fact that reflector design is one of the matters in which the lighting engineer should be proficient, whereas it is improbable that the pure "conceptionist" would be able to tackle such and allied technical problems.

# Department Store Lighting

## Factors Influencing the Design*

By ALAN W. JERVIS, Assoc. I.E.E. (Member)†


### Synopsis

The lighting of large stores has not always in the past received the detailed attention, which is so necessary for its particular requirements. These requirements vary with almost each and every store and are bound up with the economics of store operation together with the atmosphere that has grown up with the development of each particular store.

The cost of electricity plays an important role in deciding whether or not a store can afford to have the best lighting, whilst the interior structural layout affects the actual design. Intensity of the lighting must be viewed in regard to the effect on coloured merchandise, and the choice of hard or soft illumination will depend on the class of store.


### Introduction

In considering the lighting of large stores it is important to remember that in this country stores have rarely started their existence as such, but rather are the result of successful trading in small shops which have gradually extended their scope and acquired adjacent premises: in due course, they have been obliged to reorganise the space and have then been rebuilt as single units.

The large stores form the high peak of free enterprise and set a standard of customer service that is imitated by their competitors. The successful store retains the individuality that has characterised its growth, and with which it has developed its own particular atmosphere and goodwill; these are considerable factors and count for a great deal, even in this standardised age. That lighting must play a large part in the continuance of this individuality is undeniable and it is essential in the preparation of future lighting schemes that the background and economics of individual stores be borne in mind.

Because of this and because of the complex nature and wide field of the problem, there is very little definite information available for illuminating engineers, a fact that is to be deprecated in view of the large schemes of reconstruction that will have to be undertaken, as a result of war-time destruction. It is the object, therefore, of this paper to make known such facts as have emerged and such experience as has been gained in this field over a number of years.

Store lighting covers a very diversified range of lighting applications, of which the following are typical: workrooms, offices, packing rooms, restaurants and cafeteria, showrooms, windows, stage parades, exterior floodlighting, signs (internal and external) all of which, though needing individual treatment, must be correlated to the complete scheme.

It is not proposed to deal with all these sub-divisions in this paper, but rather to confine attention to those with which the customer comes in direct

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contact; the others are of more standard design and, providing their treatment is in keeping with the whole scheme, can be dealt with as such. Of the sections with which the shopper comes in personal contact, and which must conform to the traditions of the store, by far the most important is showroom lighting and it is this field which will be dealt with in the greatest detail.

## Prior Consideration

The most successful scheme of store lighting is the one that gives complete satisfaction over a period of years. In the past too many schemes have fallen into misuse because, although good as lighting schemes, they failed to take into consideration the full economics of store operation. These are a determining factor in any scheme, because no store can afford to operate costly experiments and still remain a successful store.

It has been assessed that the total cost of supplying light, heat and power to a store should not exceed 1 per cent. of the total turnover and of this 1 per cent. lighting varies approximately between 50 per cent. and 75 per cent., covering the cost of electricity, together with lamp renewals and labour. These will, therefore, form the primary points to bear in mind and some knowledge of their ramifications will be helpful at this stage, bearing in mind that the revenue-producing potentialities per square foot of floor area will vary with grade of store so that stores catering for the more popular priced range of merchandise will have to light a larger area in which to do the same turnover as a high class business. (See Appendix 1.)

### Electricity Costs

The cost of electricity to departmental stores represents over 2½ per cent. of the total cost of trading and is thus an important item of operating expense. This cost is reflected to the extent of more than a penny in the pound in the price of goods sold to the public. There is a belief in some quarters that the margin of profit in retail distribution is so high that the store can pay a high price for electricity. Actually, the store must compete for trade in a highly competitive market, and in these days of price fixing the margin of profit is under statutory control. It is the constant endeavour of the distributor to reduce the price at which his goods are offered for sale, and even before controls came in his margins had become as low as in any other industry or service. When electricity charges are excessive he is impelled to reduce his consumption to the bare minimum necessary to the conduct of his business, to the detriment of the attractiveness of the amenities of the store and the scope with which he can adopt new schemes of lighting.

The potentialities of electricity supply, as related to lighting problems, are such that with a tariff giving a promotional element, whereby the running cost is separate from the fixed charge, the actual incidence of cost is reduced to a minimum. The tariffs available to stores vary over the whole country, and it is in the interest of lighting development that these should be standardised in such a form as will permit the adoption of a high standard of lighting, without prejudice either to the store or to the electricity authority. A tariff whereby the fixed charge is based on rateable value or site area is best for this, and whilst the more usual maximum demand or installed load systems are sometimes preferred, these are both inclined to put a brake on full lighting development. (See Appendix 2.)

Light for the stores is equivalent to power for the factories and should be treated as such. It is not proposed to go into the full technicalities of the use

of electricity in stores, but it is hoped that the above comments will help to show that a prior study of this factor can be of material assistance in the future.

**Lamp Renewals**

In these days of quality production there is little to choose between the lamps of reputable manufacturers, but even with the best control in the world early failures will occur. If these are in a section inaccessible by ordinary methods it may be some time before renewal can take place. Even when this is done promptly the cost of changing the lamp can often equal the cost of the lamp and may be anything between 1s. and 20s. The disturbance caused by carrying this out during business hours can upset a potential customer and mean further losses. With reliable lamp life regular renewal during cleaning periods is possible.

One might be led to think from this that lamps lasting the greatest number of hours would be the best proposition, but in these days of increasing lumen efficiencies a lamp whose economics are dependent on long life might bar the user from taking advantage of technical improvements. What is wanted, therefore, is reliability to fulfil its stated performance.

**Labour Costs**

These are reflected in the costs of keeping installations in full running order whether by lamp renewals, cleaning, or changing damaged materials. They can be reduced to a minimum by proper thought being given to the design of fittings and of easy methods of cleaning and access to essential parts, remembering that standing on the top of a tall pair of steps is not the ideal position in which to manipulate small set-screws, and as yet no reliable method has been found for only one man to cope with long tubular lamps in such a position.

There are many other points which could be considered under these headings, but it would need a paper of much greater length than this to deal with all the various aspects, and it is hoped that the brief resumé given will be of assistance to designers.

## Basis of Design

Stores are generally multi-floored premises, covering large-site areas, with a variety of goods not usually found in the ordinary shop. They vary in the grade of merchandise and may be of a high, medium or popular class. They are situated in many different types of localities (this is generally reflected in the grade of merchandise sold), and their exterior appearance may be anything between imitation Tudor and modern chromium and glass. Each type will need individual treatment and the retention of its characteristic atmosphere. A good lighting scheme, therefore, must be in keeping with the style, whilst at the same time providing a modern standard of illumination which must enhance the value of the merchandise. It is a natural trait of individuals that they like other people to think that the goods they have bought are of better quality than would appear from the cost. This is particularly so of the female sex, and as they form by far the greater percentage of store customers their pleasure becomes an important feature of customer service.

On account of the great number of variables involved no one can state hard and fast rules on how a scheme must be designed, but after steeping himself in the local atmosphere, should study all the different parts of the jig-saw and, based on experience, put them together to form an entire picture.

In the past, eagerness to lead competitors in matters pertaining to efficient

merchandising has not always been to the advantage of the store; each striving to be different and ahead has often led to the adoption of equipment entirely unsuitable for its particular needs and for this reason alone mass-produced lighting design will fail. The lighting industry has a responsibility in ensuring that technical advances made in light sources are reflected in the basis of fittings design.

Each store has been developed on its own individual atmosphere which must be reflected throughout the premises, and for this purpose lighting can be divided under two main headings: (a) hard—or direct lighting; (b) soft—or dispersed lighting.

To vary the atmosphere, one can alter the degree of "hardness" to suit the class of business. A popular-class business will need the hardest light, while an exclusive salon will need the softest, with a wide choice of intermediate stages. The atmosphere will be affected both by the grade of merchandise and by the situation of the premises.

**Situation**

The locality of the store is of considerable importance, especially in the provinces, where local traditions and the proximity of historical monuments will influence the customers' outlook in what is right and wrong. In this instance the case of a cathedral town might be quoted where, as everybody knows, the inhabitants of the cloisters exercise a deep influence on local matters and a modernistic interior design would not be in keeping in the traditional dignity.

Whether the store is situated on the north or south side of the road will also have a bearing on lighting design, as will the amount of sunlight normally affecting the interior. It has been found that the *harder* the lighting, the better

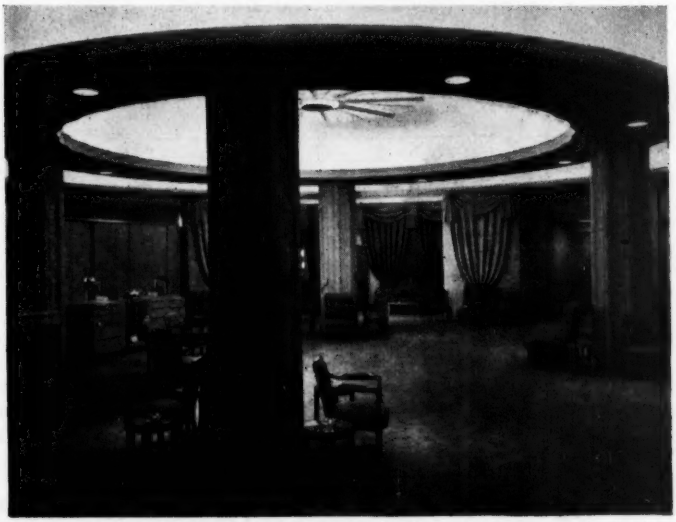

Fig. 1. A specialist department in the centre of a large showroom. (Marshall Fields, Chicago '28' shop.)

it mixes with sunlight, whilst totally indirect lighting schemes look depressing during that period of semi-daylight which precedes complete darkness. This same effect is noticed where the showroom receives only reflected daylight—where the windows face on to a courtyard or something similar.

This effect of daylight was receiving increased attention before the war, and several prominent store executives were reviewing the possibilities of stores without windows, being completely dependent on artificial lighting. The first post-war store built in the U.S.A., at Houston, is based on this principle, and the only windows, other than those for display at ground-floor level, are adjacent to stairways.

Daylight is a most expensive commodity, especially when full value has been placed on the loss of display space, cost of installation of windows, cleaning, insurance, etc., but there is the very bad psychological effect if it is excluded, which must be considered first.

**Interior Layouts**

It is in interior layout that the store varies so much from the ordinary shop, both in the long vistas and in the absence of the cosiness given by the close proximity of wall surfaces. This cosiness is very conducive to good sales, and there is a tendency for the modern store to be split up into more individual sections by the erection of screens and partitions. The small area also looks brighter for the same expenditure of watts per unit area. Again, most stores have special sections devoted to some range of merchandise not in general keeping with the remainder of the store, and to emphasise these in the middle of a large showroom is difficult. For this reason, stores have been installing what is popularly known as a "shop within a shop," and instances of this can be seen all over the country. (Fig. 1).

Different floors have been, by long usage, distinctive to different types of merchandise, such as:—

Basement: Furniture, Linens, Household Ware, etc.
Ground Floor: Hosiery, Perfumery, Handbags, Gloves, etc.
Upper Floors: Fashions, Restaurant, etc.

Each of these departments has its own methods of presentation, and we find that whilst the upper floors are generally equipped with display cases along

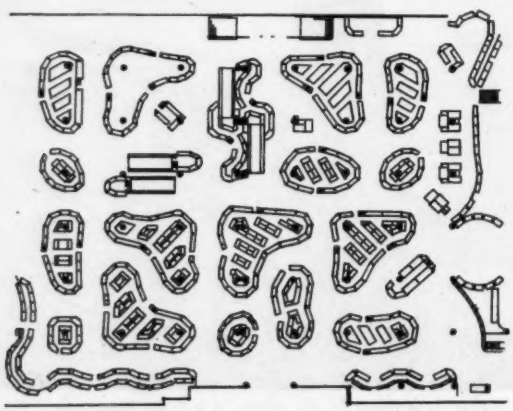

Fig. 2. Typical new curved counter layout of a ground floor showroom.

the walls, the ground floor is served by counters, the basement being a mixture of both styles.

It will be seen from this that each floor must have a different style of lighting, and it has been found that the public is more conscious of the lighting on upper floors than on the lower, a point of importance to remember when considering the type of fitting to be installed. One reason for this is that when people are ascending they automatically look up, and when descending they look down; hence on the upper floors they see the cause of the lighting before they are attracted by the result.

The formation of the counters on the ground floor is now feeling the effects of modernisation and the familiar "grid-iron" pattern—is giving way to curves, in order to lead the customers to visit the more remote sections of the floor. (Fig. 2).

Structural features of the interior influencing the lighting design are position and sizes of partition walls, height of ceiling, position and depth of beams, size and type of windows, position of stair wells, number and size of supporting columns, ventilation ducts, sprinkler system, and all the great number of water, other pipes and cash tubes that are always positioned just where the lighting should be fixed. (Figs. 3 and 4.)

Fig. 3. Non-uniform pattern of beams producing dark sections on the ceiling.

A great many of these can be varied, especially in new buildings, by good co-operation between the architect and the lighting engineer, but others—such as sprinkler heads—are fixed by building regulations and cannot be varied. These are a particular nuisance now that the large fittings, suitable for fluorescent lamps, are being used.

The colours of the walls, floor coverings and ceiling not only have a marked effect on the apparent brightness of the showroom, but their variation can alter the degree of hardness of the lighting: further, their correct use as a background to the display of merchandise will help to attract the customers' attention. In this respect a common fault is to make the wall surfaces so light that any merchandise stands out as a silhouette and thus loses most of its appeal. Many stores are using pastel tints of green, pink, or blue for their wall surfaces, quite often different in each section or department.

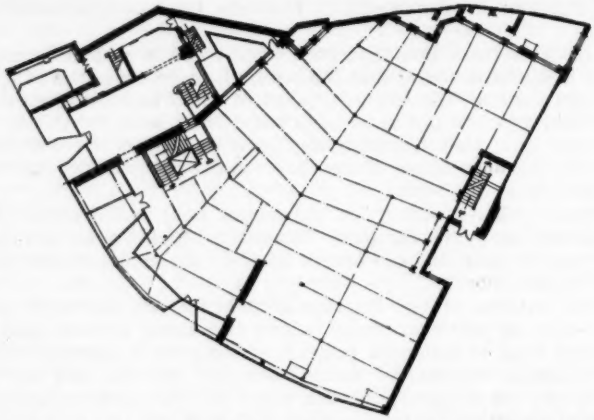

Fig. 4. Irregular plan of ground floor makes symmetrical layout of lighting difficult.

**Arcades**

The ground floor lighting, as well as conforming with the interior design, should take account of the nature of the entrance to the stores from the street. If these are approached via a lengthy arcade, then the intensity of illumination need not be so high as would be necessary if the door abutted directly to the street. Most of the large stores have imposing entrances, with lobbies, and many have extensive arcades intended to provide a large exterior display area, so as to attract the casual customer. There is, however, a growing tendency to do away with this feature.

## Technical Consideration

**Illumination**

The intensity of illumination, having a direct relation to most of the abstract factors discussed before, will be the first stage in actually designing the installation. A basic value must be fixed which can be carried throughout the store, and variations to suit individual requirements must not upset the balance of design; increasing the illumination, so as to bring a special feature into prominence, if the contrast is too great, will act to the detriment of the surroundings.

There has been a definite trend during recent years for the general level of illumination to be increased, due to: (a) cheaper electricity; (b) propaganda by lamp manufacturers and electricity suppliers; (c) realisation of the benefits of high-level lighting; (d) indiscriminate use of floodlights.

Of these (a) and (c) are of the greatest practical assistance for the future of good lighting, whilst the effect of (d) has often been to cause an upheaval when the quarterly electricity account arrived. The level of illumination *must* be related to the overall cost of obtaining that light. (See Appendix 3.)

The requirements of store lighting are general lighting plus highlights. Having fixed a datum level, on which to start designing, one should then select the points of emphasis. These points of emphasis should be used to bring out special features of the display, attract customers off the normal traffic lines, help them in locating themselves and the departments they want, and also help to give each department a distinctive feature that will be retained in the customers'

minds (Fig. 5). The highlights will help to break up the uniformity of large areas, where the same level of lighting throughout would appear flat and unattractive. The number of points where highlights will be of assistance will vary with the structural layout. In considering the amount of general lighting we must also give thought to the effects of shadows. No object would be recognisable if it were not for the varied shadow contrast, so it is important that in our haste to provide good overall illumination we do not make it too nearly shadowless. The richness of draped material is completely lost, as is the form and modelling of a garment, with a flat light; what is needed is a mixture to give soft or hard lighting as required (Fig. 6).

Pre-war lighting levels in this country were between five and eight lumens per square foot on upper floors, and slightly higher on the ground floor. To-day the introduction of more efficient light sources (and to a certain extent the reaction against war-time blackout) has helped to raise this figure to between 15 and 20 lumens per square foot for general lighting and 25 to 30 lumens per square foot for special features. This is a big move forward, and its maintenance will depend on the future cost of electricity and any further increases in lamp efficiency. It should be noted that these last figures are for installations employing relatively hard lighting in modern fluorescent fittings, and that no large-scale attempt has yet been carried out with totally indirect lighting at these levels. A check taken of a great number of trial installations has proved that this is the highest economical level, bearing in mind operational expenses, that can be allowed at the present time. It is stressed, however, that they are average figures, and refer to buildings with normal interior proportions, particularly ceiling height.

Because of the higher daylight illumination in summer, as against the darker months, higher interior illumination is required in the summer, especially in the ground floor. If the scheme incorporates a means whereby the intensity can be lowered, when not required, without upsetting

Fig. 5. Ground floor plan of a large store.

O—> Direction of traffic flow.

⊠ Points where emphasis lighting could be used with advantage.

the balance of design, it will help not only the store but also the electricity authorities' supply capacity; this is well worth considering at the present time.

One sideline on the question of the general illumination level is the effect on illuminated direction signs. The most popular of these pre-war were those whereby a striplight lamp, shining through the edge of a glass panel, threw etched letters into relief. The brightness of this type of sign is restricted by the efficiency of the lamps, and it has been found in some of the trial installations, using higher intensity lighting, that it was impossible to see whether the sign was in use or not. Signs might well be incorporated into the general lighting design.

**Light Sources**

From the early days of the carbon lamps to the present time, stores have been amongst the first users of any new electrical illuminant; with each new development has come fresh problems associated with their use, not the least of which has been the appearance of the merchandise. The increasing efficiencies of light production have been of the greatest benefit in making the stores what they are to-day, and a large debt of gratitude is due to those responsible. It is hoped that the close co-operation that exists between the large stores and the lamp manufacturers has been of some assistance in lighting research.

The characteristics of the gas-filled and vacuum lamps are too well known to merit any further description here. Two recent developments of great importance are the fluorescent lamp and the "reflector spot lamp." As the latter is really an offshoot of the gas-filled lamp, it will be dealt with first.

In this lamp (Fig. 7) the prominent feature is the internal mirrored surface of such a shape as to give a concentrated beam of light. Its great value in store use is to provide the "*punch*" necessary for the special emphasis required for window lighting and similar applications. Its light maintenance factor is high, as no dust can spoil the reflecting surface, and its overall efficiency is very much

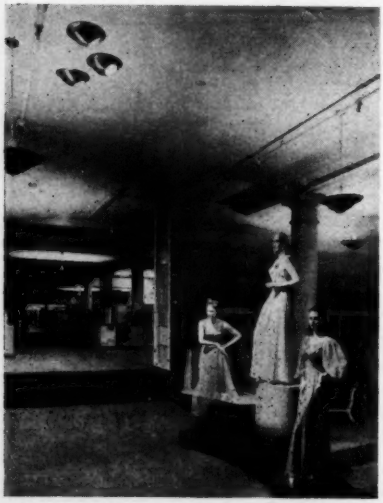

Fig. 6. Indirect lighting and emphasis by spotlights. (Macy's, New York.)

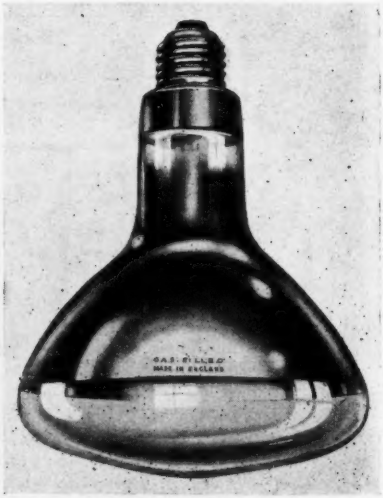

Fig. 7. Internally mirrored reflector spot lamp.

higher than an ordinary lamp of the same wattage with an external reflector. Considerable use has been made of these lamps in the U.S.A., where they have been available for some time, and most up-to-date schemes include some applications.

**Fluorescent Lamps**

Never has so much controversial argument raged about a new light source as about the fluorescent lamp, and much of it can only be described as "hot air," due to a lack of understanding of its potentialities. It can be safely stated that the fluorescent lamp has given the greatest impetus to the development of good lighting that has ever taken place—in spite of the great number of early installations that can only be classified as "eyesores."

It is the first major departure from the point source of light and allows an entirely different form of treatment to be used. It has, we know, some disadvantages, amongst which are:—

Need for auxiliary control gear.
Non-instantaneous start.
High initial light flux, compared with average during life.
Colour rendering of light.
Loss of light output when used in fittings with more than one lamp, unless the spacing is exceptionally great .

On the credit side we have:—

Low surface brightness.
Low temperature rise.
High lumen efficiency.
Long life.
Ease of concealment in cornices, etc.

Of the disadvantages, the most important to stores is the *colour* of the light, and investigations are being made in an attempt to correct this fault. Commercial application must be the criterion of the value of a new lamp, and as it is not possible to cater for all conditions of application in the laboratories, it is only after lamps have been marketed that a full assessment of their limitations can be made. Now that their use is developing in the higher class business, a definite reaction against the colour rendering of merchandise and features is growing. It is only fair to state that in the past the research workers of the lighting industry have been quick to appreciate and cater for commercial needs. So it will be with the fluorescent lamp, and there is no doubt that our major complaints will soon have been eradicated.

With the present prices of these lamps, there is no financial benefit in their use where electricity is very cheap, but as it seems to be accepted that the cost per unit of electricity is bound to rise, owing to increasing costs of fuel, then it may be reasonably assumed that in the future fluorescent lamps will be brought into greater use. (See Appendix 3.)

**Colour**

In studying the lighting requirements of stores it must be clearly borne in mind that the one and only object of the lighting installation is to help sell the merchandise. If the scheme fails in this respect it is merely a waste of time, material, and money. It follows, therefore, that close attention must be paid to the actual merchandise.

Coloured light, being unusual, has the power to attract people, and in some departments the use of colour has been found to enhance the appearance of a particular material, as in the use of pink light in meat departments. As a rule,

however, coloured light is used mainly for special effects. Customers usually wish to see the merchandise they are buying under lighting conditions comparable with those with which the goods will be used; distortion of the light will, therefore, most likely lead to the customer's dissatisfaction.

**Table 1**

**Effect of Juxtaposition of Colours***

(When colour A is viewed in close proximity to colour B the apparent effect on colour A is that shown in column C.)

| Colour viewed A | Neighbouring colour B | Colour A appears C |
|---|---|---|
| Red | Orange | Purplish |
| Red | Yellow | Purplish |
| Red | Blue | Orange-Red |
| Red | Violet | Orange |
| Orange | Red | Yellowish |
| Orange | Green | Orange-Red |
| Orange | Blue | More brilliant |
| Orange | Violet | Yellowish |
| Yellow | Red | Greenish |
| Yellow | Green | Orange-yellow |
| Yellow | Blue | Orange-yellow |
| Greenish-yellow | Violet | More brilliant |
| Green | Orange | Bluish-green |
| Green | Yellow | Bluish-green |
| Green | Blue | Yellowish-green |
| Green | Violet | Yellowish-green |
| Blue | Red | Greenish |
| Blue | Orange | More brilliant |
| Blue | Yellow | More brilliant |
| Blue | Green | Purplish |
| Blue | Violet | Greenish |
| Violet | Red | Bluish |
| Violet | Orange | Bluish |
| Violet | Yellow | More brilliant |
| Violet | Green | Purplish |
| Violet | Blue | Purplish |

* Derived from "The Principles of the Harmony and Contrast of Colours," by M. E. Chevreul.

With tungsten lighting the public had become acclimatised to the effect of a light rich in red and yellow. Early use of daylight matching units was soon discontinued, although it is still the practice of some people to take the merchandise to the nearest window or doorway. With the advent of the fluorescent lamp there was, at first, a feeling that at last we had solved this problem, and then came a spate of returned merchandise and customers' complaints. If we are to have completely satisfactory lighting in the future, the problem of colour rendering will have to be given still more attention.

Coloured material is the life blood of the store. How then does it look

under conditions of artificial light? We know that with tungsten lighting an intense light has the property of modifying colours, due to the increased luminosity effect produced, tending to give the colour a bias towards light yellow, whilst at low illuminations it gives a bias towards dark blue.

Taking green as an example, we find that on increasing the intensity of light it first appears to be yellow-green and then, as it is further increased, greenish yellow, and, finally, when it has reached saturation point, a whitish yellow. The resultant effects will depend on the texture and lustre of the particular material and also on the amount of diffusion, as well as the spectral reflection characteristics of the material. Whatever the intensity, materials retain something of their basic colour. Now we have the new coloured light emitted from fluorescent tubes, and our colour troubles are starting all over again. Neither of the standard colours now available is suitable for every purpose. The daylight tubes are reasonably good for blues, not so good for greens, and bad for yellow, whilst the warm-white distorts badly practically all shades of colour. It will follow, then, that as different colours are affected in different ways, the effects on colour combinations will be almost unpredictable. The theory of juxtaposition of colours needs a paper on its own, but briefly, when two or more colours are alongside they each appear to take on different hues. This is why variation in colour distortion under fluorescent lamps is not constant with multi-coloured fabrics. The popular multi-coloured and patterned head scarf is particularly susceptible to this distortion. Even the styling of garments seems to vary with colour distortion, and fashion designers are complaining that dresses appear out of balance.

As explained above, whatever the colour of the light source, modifications in the apparent colour of the objects will take place with the varying of the intensity, so that it is impracticable to expect a perfect standard; what is required is a compromise that will assist, and not detract from, the sales of goods. When this is obtained attention can also be given to the colour of the interior decorations, which can be varied to suit particular ranges of merchandise.

**Glare**

The glare problem in stores can be classified under two main headings—that caused by daylight entering through windows and skylights and that caused by the artificial lighting. On bright days it is very uncomfortable to look at merchandise against a background of light entering windows on the upper floors, and one reason why most sales are effected near the windows is because customers wish to get the light behind them. On these days, therefore, the rest of the floor is wasted space: this is another reason for considering windowless buildings.

With artificial lighting the long vistas tend to low angles of view, and even fittings with a low surface brightness can cause discomfort when seen in contrast to darker backgrounds. These contrasts might be between the fitting and the wall surfaces, or even the ceiling, and though they can never be entirely eliminated from all angles they can, with the correct mounting height of fittings, be reduced to a minimum. As this mounting height is not always in accordance with the accepted length of suspension fitments provided, more thought should be given to help make the non-standard requirements easier to obtain. It is not always the installation using fittings, as opposed to built-in lighting, that causes the most glare; too high a surface brightness, with indirect lighting schemes, can be equally uncomfortable. (Fig. 8.)

Fig. 8. Too high a ceiling brightness in relation to light on the merchandise.

## Special Applications

### Window Lighting

Windows form the first introduction to a store's merchandise, and the art of window display has reached a high level of ingenuity. The windows must have an instant appeal and for this reason the level of lighting must be higher than in the interior. Facilities for the use of coloured lighting and stunt effects will be required. It has been found that it is mechanically impossible to provide adequate punch of light by the use of fluorescent lamps, but the combination of reflector flood lamps with fluorescent lamps as background illuminants and for side and foot lighting can give very satisfactory results.

Experiments are being made to enable cyclorama effects to be produced, thereby permitting bigger pictorial displays than in the past.

Daylight reflection on show window glass is a serious nuisance (Fig. 9). Attempts to compete with reflections by increasing the lighting intensity have not been successful, but it is hoped that full commercialisation of a non-reflecting glass will be a possibility in the not-so-distant future: and then we shall have to put bars up to prevent people walking through the glass.

### Restaurants and Cafeteria

There is a growing demand for quick eating facilities, and most large stores are installing self-service cafeterias, as apart from normal restaurants. In the latter, the accent should be on comfort and restfulness by means of soft lighting, while in cafeterias it will be the reverse, to induce people to finish and move out quickly (Fig. 10).

### "Heat Lighting"

It may be that future illuminating engineers will be called in to provide the heating requirements of interiors should research and experiments now

Fig. 9. Daylight reflection in arcade windows.

being carried out prove successful. In these, infra red lamps are being used to provide personal heating, as against space heating. Such heating would be a great saver of fuel and considerably reduce the heat losses of a building, which so greatly affect the efficiencies of most heating systems.

The method has many advantages although it is too early to forecast its ultimate future, and there are many details that have to be investigated. But

Fig. 10. Cafeteria lighting using partly louvred fittings.

we may yet see units using ordinary floodlights in the summer and infra red lamps in the winter.

## Future Development

How will all these different and complex factors affect the future design of store lighting? The answer is, in many ways. The store executives know that as the public are becoming more discriminating in their custom, every possible aid to sales must be used to the utmost. The lighting must become an unconscious part of the store's service.

The exact details in each store will depend on the versatility of different lighting engineers, but must cater for the type of lighting which has been described above.

Dr. J. W. T. Walsh, in a foreword to a recent book, states that "the final judge of any lighting scheme is the eye . . .," which must be the basis on which

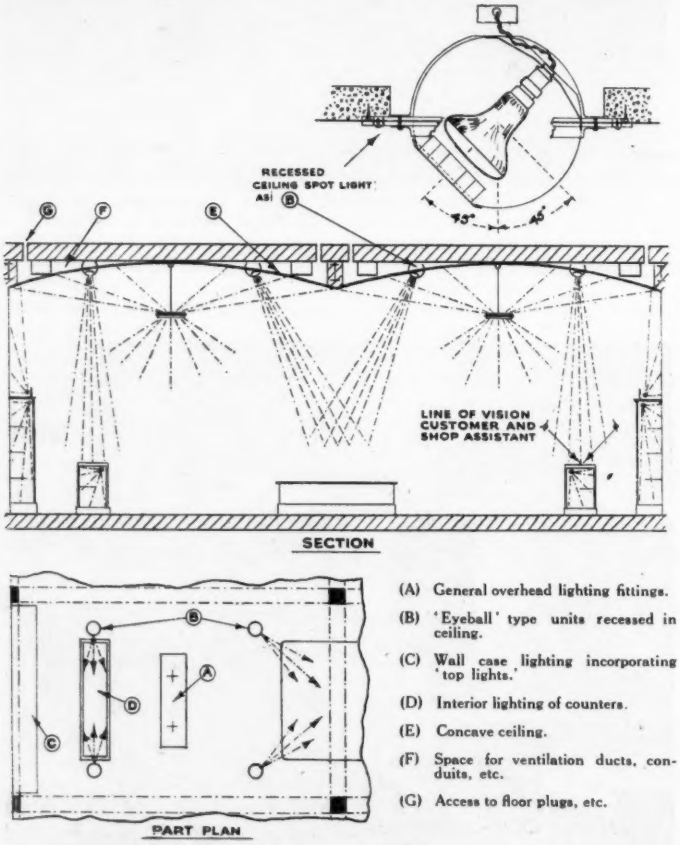


Fig. 11. Suggested scheme for lighting a ground floor showroom. (Load approx. 3 watts per sq. ft.)

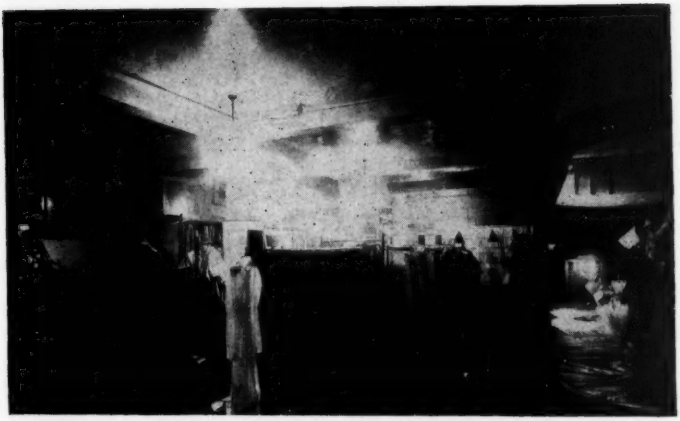

Fig. 12. Poor brightness distribution.

all the various elements of store lighting are co-ordinated. The lighting requirements may be summarised as:—

*General Lighting* from suspended fittings or recessed panels on the ceiling, all of very low visible surface brightness, and generally using fluorescent tubes,

and

*Emphasis Lighting* of counters, wall fixtures, special displays, and ornamental features, by use of either fluorescent tubes or reflector spotlamps. (Fig. 11.)

In general a larger percentage of soft lighting, as opposed to hard, is required on fashion floors, the reverse being the case for ground floors. There must also be a definite relation between surface brightness of walls, floor, ceiling, and merchandise, or, as defined by Ward Harrison, of the U.S.A.—"brightness patterns." (Figs. 12 and 13.) In brief, it must be generally realised that light in stores is to *sell* by and not merely to see by.

Fittings must be capable of being adapted to suit individual building characters; they must be light in weight and easy to maintain in good condition. Their designers must take a bigger personal interest in the actual installation for which the fittings are intended.

Whole or partially louvred ceilings are being adopted in some American stores, but their use must be carefully considered in relation to the individual premises. While they have certain advantages, the installation costs are high and there is a potential danger of making the apparent brightness of the ceiling too high, and—of special interest to us—they need a high installed lamp load to ensure even illumination of the louvres.

Wiring facilities in the building must be sufficiently flexible to allow for adjustments of the lighting without a multiplicity of temporary cables strung all over the ceiling. (Fig. 14.) Co-ordinated switching arrangements are needed to cater for different daylight conditions.

Can we obtain these and still maintain the balance of store expenses and economics? Experience has shown that it is no more expensive to have good

Fig. 13. Modern louvred ceiling fittings in a fashion showroom.

lighting than bad, and it is up to all lighting engineers to see that they install good lighting.

## Conclusion

In ending it might be stated that it is not always a question of whether a store can afford to have good lighting, but rather whether it can afford not to.

Fig. 14. A pre-war lighting installation in the 'development' stage. Note loose wiring and floodlights.

In this country distances between large towns are not great, and with the travel facilities available the public has a wide choice of markets. Even a small adjacent shop with good lighting can upset the whole economic outlook of the large stores.

Finally, department stores, through their own usage, represent in themselves a most effective means of educating the public in the use of lighting. They can show where and to what extent it can be used over an enormously diversified range of services. They are themselves interested in, to a large extent, the sale of domestic fittings, and as leaders of public taste and fashions, particularly in interior decoration and furnishing, they can, with a little encouragement, be rendered very powerful agents for the future of good lighting in this country.

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## Appendix 1

### Store Operating Expenses

To give some idea of the various costs constituting the operating expenses of a store, the following schedule shows the average costs, expressed as a percentage of sales turnover, of 39 stores over the year 1939 (the last true year

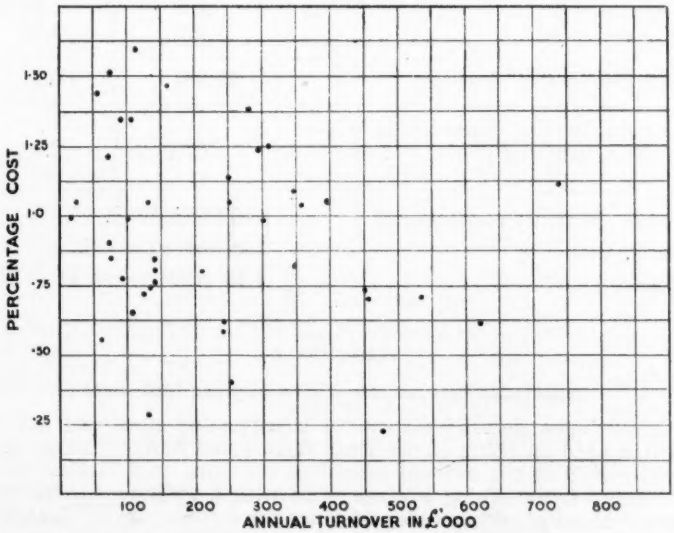


Fig. 15. Store operating expenses. Shot target showing percentage cost of heat, light and power in 39 stores.

for basic comparison). A check of the year 1946 shows that while the total operating expense ratio is approximately the same the various items have a considerable variance. Salaries and wages now form nearly two-thirds of the total and heat, light and power has decreased to .5 per cent. (showing the effect of fuel restriction and store savings). How the increased wage ratio will affect store economics in future years has yet to be considered. The shot target (Fig. 15) shows the various percentages of heat, light and power for the 39 stores.

**Schedule**

| Expense item | Percentage of Sales | Percentage of Expenses |
|---|---|---|
| Salaries and wages ... ... ... | 11.674 | 54.62 |
| Transport ... ... ... ... | .974 | 4.56 |
| Publicity ... ... ... ... | 1.351 | 6.32 |
| Display ... ... ... ... | .478 | 2.23 |
| Postage and receipt stamps ... ... | .219 | 1.02 |
| Sundry expenses ... ... ... | .269 | 1.26 |
| Printing and stationery ... ... | .217 | 1.01 |
| Rent ... ... ... ... ... | 1.980 | 9.26 |
| Rates and water ... ... ... | 1.052 | 4.92 |
| Repairs and renewals... ... ... | .578 | 2.74 |
| Heat, light and power ... ... | .911 | 4.29 |
| Telephones ... ... ... ... | .091 | .43 |
| Subscriptions and bad debts ... | .189 | .88 |
| Insurance ... ... ... ... | .409 | 1.91 |
| Depreciation ... ... ... ... | .975 | 4.55 |
| Total operating expenses ... ... | 21.367 | 100.0 |
| Electricity cost (included in above heat, light and power) ... ... | .620p.c. | 2.90p.c. |

| | | |
|---|---|---|
| Average electricity consumption | = | 216,442 K.W.H. |
| Average cost | = | 1.46 pence per unit |
| Electricity costs | = | 1.48 pence in the £1 of sales |

## Appendix 2

### Relationship between cost of electricity and load factor

With maximum demand systems of charging for electricity the average price will depend on hours of use (load factor) and different bases of assessment will give different average prices for the same load factor. In Fig. 16 Scale A shows the resulting average price with a tariff of £12 per kilowatt maximum demand per annum, plus .50 pence per unit consumed. Scale B shows similar tariff based on £6 15s. per kilowatt per annum plus .75 pence per unit consumed.

**Rates in pence per unit**

| Load factor | "A" | "B" |
|---|---|---|
| Per cent. | | |
| 100 | .828 | .916 |
| 90 | .866 | .934 |
| 80 | .911 | .957 |
| 70 | .970 | .967 |
| 60 | 1.044 | 1.020 |
| 50 | 1.157 | 1.082 |
| 40 | 1.322 | 1.165 |
| 30 | 1.596 | 1.303 |
| 20 | 2.142 | 1.590 |
| 10 | 3.787 | 2.410 |
| 5 | 7.174 | 4.070 |
| 1 | 33.370 | 17.150 |

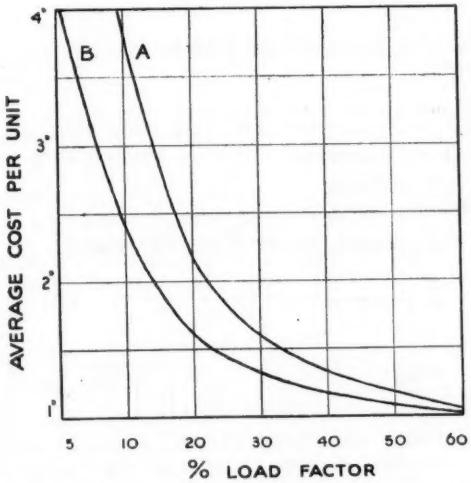


Fig. 16. Relation between load factor and average cost per unit of current.

## Appendix 3

**Annual costs of lighting an area of 10,000 square feet**

| | |
|---|---|
| Intensity ... ... ... ... | 10 lumens per sq. ft. |
| Coefficient of Utilisation ... ... ... | .50* |
| Depreciation factor ... ... ... | 1.28* |

* Based on Illumination Design Data (E.L.M.A. Lighting Service Bureau).

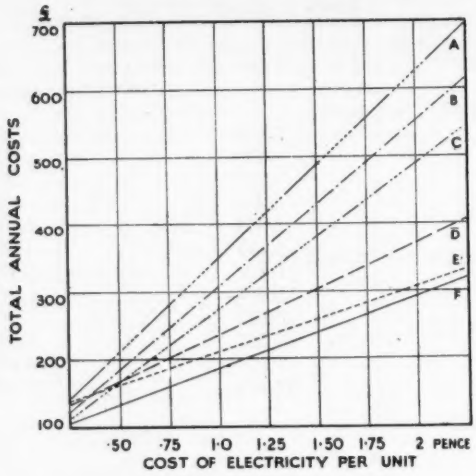


Fig. 17(a).

Scale A using 100 watt lamps in opal fittings.
„ B „ 150 „ „ „ „ „
„ C „ 300 „ „ „ „ „
„ D „ H.T. cold cathode 3-light bare lamp unit.
„ E „ 40-watt fluorescent lamps in either plastic-shielded or louvred 3-light fittings.
„ F „ 80-watt—as "E."
(*Note*:—150-watt and 200-watt are practically the same.)

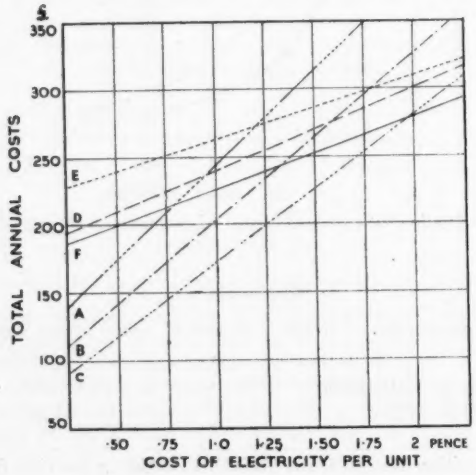


Fig. 17(b).

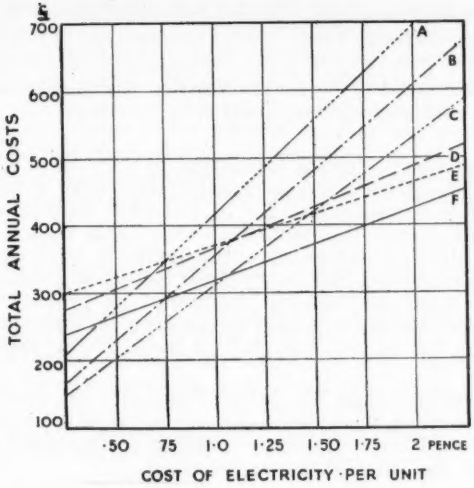


Fig. 17(c).

Fig. 17 (a) Shows annual costs of lamp and current only over a period of 3,000 hours.

Fig. 17 (b) Shows annual costs as graph (a), plus depreciation, over a period of 1,500 hours (equivalent to a 17 per cent. load factor, normal for upper floor (showrooms).

Fig. 17 (c) As graph (b), over a period of 3,000 hours, i.e. 34 per cent. load factor, normal for basements and ground floor showrooms.

Prices of lamps and fittings are as at March 16, 1948, and depreciation of fittings and installation are taken at 12½ per cent. per annum.

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## Discussion

In opening the discussion, MR. OSCAR C. WAYGOOD said that in the past neither the lighting nor the installation methods had been all that the stores needed. In opposition to the author, he considered that one standard system and a single type of fitting should be used throughout, adaptable for either direct or indirect lighting. He would not design the lighting to suit the turnover but would let the latter follow the former. The system must be flexible for quick modification when changes of display took place.

MR. J. G. CHARLTON asked if there was any special rule applying to the spacings of louvres. The author exhibited louvres with spacings of 1½ or 2 in. and he inquired if there was any technical reason for that or if it was purely an artistic idea.

MR. R. G. PAYNE asked whether, in view of the fact that the paper covered

lighting only, the author would consider the lighting of stores by gas and so get heating at the same price!

MR. I. M. HEALD asked if there were any figures available of tests indicating the results to be obtained with different types of louvre.

MR. W. IMRIE-SMITH, referring to the type of problem in which utility lighting went hand-in-hand with maintaining the decorative appearance, said that in such cases it was necessary that the illuminating engineer and the architect should work together from the start. Referring to the illustration in the paper showing general lighting and accentuating lights, it was noticeable that even in this relatively simplified case an artificial ceiling was indicated. It seemed to him that to obtain the required flexibility the provision of an artificial ceiling became essential and it should be designed for adaptability, like a stage floor, so that the fittings could be moved to meet the requirements of the different displays.

This, incidentally, raised an interesting point in connection with the economics mentioned by the author; one of the major capital outlays on such an installation would come under the heading of structural costs and would not be saddled on the illuminating engineer.

MR. J. C. LOWSON, referring to the use of infra-red lamps for personal heating in stores, asked whether filters were employed to deal with the visible radiation. if not, how was this prevented from interfering with the ordinary lighting of the store?

MR. L. J. ROBERTSON (*communicated*): Mr. Jervis refers to pre-war lighting levels being around 5 to 8 lumens per sq. ft. whereas to-day the tendency for "hard" lighting schemes is 15 to 20 lumens per sq. ft. plus special feature lighting. He further states that "no large-scale attempt has yet been carried out with totally indirect lighting at these levels."

In this connection I should like to mention some installations in Australia 10 years ago. These concerned department stores of the largest size, both of the "five-and-ten-cent" and the "high-class" types, where indirect lighting at 15 to 20 1/ft.$^2$ was achieved by 500 and 1,000 watt general service lamps located in indirect floor standards of effective design. These standards were so placed that no interference with customer traffic was caused and were easily reached for maintenance.

The first installation of this kind was, not surprisingly, unsatisfactory as a sales aid; for there was a tendency to general flatness with almost an air of repose over the display areas. Considerable improvement was obtained by adding local lighting concealed in the display counters, show cases and in alcoves, etc.

Finally an installation was completed in Sydney in 1938 where flush-mounted louvred concentrating downlights were set in the ceiling at suitable intervals to highlight the goods in addition to the 20 1/ft.$^2$ secured by the totally indirect floor units. This system could perhaps only be bettered to-day by the use of the adjustable "eyeball" devices employing the silvered projector lamps.

Contemporary with the above schemes was another featuring only direct lighting provided by luminous panels set flush in the ceiling in association with a pattern of concentrating downlight panels. The result compared with the

methods previously mentioned was not at all happy since the brightest objects in the field of view were ceiling lights surrounded by the relatively dark ceiling areas. An atmosphere of heaviness overhead was experienced, and whilst the illumination on the goods was around 12 1/ft.$^2$ the overall effect, in the opinion of many, was inferior to the indirect-plus-downlight system. The post-war use of fluorescent lamps in the general lighting panels in this store may have resulted in improved efficiency, but not effectiveness.

The indirect-plus-downlight method proved especially good in low-ceiled basement areas; for it produced an effect of greater ceiling height and spaciousness.

MR. HOWARD LONG (*communicated*): It is refreshing to have a paper of this type presented by one who has had much experience in such a field. The author rightly points out that whilst the application of fluorescent lighting to stores can be very successful, it has to be done with care.

Examples of returned merchandise have come to notice. A particular case was where a shoe factory used this type of lighting in the shoe room where shoes were matched and boxed. Only when they were opened up in the retail shops was it found that the matching was unsatisfactory.

Then, as the author says, "Coloured material is the life blood of the store. How does it look under conditions of artificial light?" One factor which has not been widely appreciated in this connection is the one mentioned by the author in this paragraph. However good the lighting, unless there is a sufficiently high standard of illumination the colour will not appear the same as when seen in natural daylight. This cannot be too strongly emphasised.

Again the author rightly stresses under the heading "Glare," the types of glare which have not been generally appreciated in the past. This is exemplified by the fact that many installations of fluorescent troughs, both hot and cold cathode, are still being carried out with bare lamps.

MR. JERVIS, in reply to this discussion, said: There is no doubt that both Mr. Waygood and myself have very much the same outlook on this problem and only differ in matters of procedure. With regard to Mr. Waygood's feeling that one standard system of lighting should be installed throughout the building, I feel that this is only possible with the more popular type of business, and that the higher-class shop very definitely needs each individual section treated on its merits. We both agree that whatever lighting is installed it should be sufficiently flexible to cater for varying types of merchandise. To base the lighting operating costs as a percentage of turnover may not be ideal, but as yet it is the most satisfactory method. It is obvious that with the control of margins and profit, stores must work to a fixed figure, based on turnover, and unless lighting costs bear some relation to this—in this case not to exceed 1 per cent.—then there is no method of assessing future improvements.

In reply to Mr. Charlton, the spacing of louvres can vary with the depth of the louvres, and it has been found that the most efficient and satisfactory basis for designing louvres is that they have an angle of cut-off of 35 per cent., with the proviso that the greater the depth of the louvre, the less will be the efficiency of the fitting. It is advisable, therefore, to have a relatively shallow louvre fitting.

The cost of lighting a store by gas, as suggested by Mr. Payne, would be prohibitive, and at the same time we should get the trouble of too much heat in the summer months.

Tests taken on louvres of the type shown have an efficiency of 90 per cent.

I am not sure if this is Mr. Heald's point, or whether he is thinking of coloured louvres, or those made of different materials, but generally a 10 per cent. loss due to louvres, is the maximum which is allowed.

The object of installing a false ceiling, as mentioned by Mr. Imrie-Smith, is both to accommodate wiring installations and also to provide a curved surface to the ceiling to assist the distribution of light from fittings. The idea of having ceilings adaptable so that the fittings can be moved to meet individual requirements is one that certainly deserves consideration, and there is no doubt that with the advent of false ceilings, made with panels, a scheme of this description could be efficiently devised.

Mr. Lowson asks whether the infra-red spotlamps would be fitted with a filter to deal with visible radiation: the point is that they will provide both lighting and heating, and in the winter the lower lighting efficiency of these lamps could be used when we need less illumination. The installation will be so designed that the light from them will blend with the general scheme of the store. There is, however, much more thought to be given to this problem before it is solved.

I would point out to Mr. Robertson that the intensities referred to on page 234 were those in general use in this country. Pre-war, however, several installations with much higher intensities were being tried. One, in course of installation at the beginning of the war, had over 50 1/ft.$^2$ of direct illumination from recessed floodlights in the ceiling, lighting only the various merchandise areas. These recessed floodlights had louvred fronts to restrict surface brightness, and there was sufficient back reflection from the merchandise and counters to ensure a reasonable intensity on the ceiling and circulation areas. I was, however, very interested in the two examples quoted by Mr. Robertson, and agree with him that the most satisfactory method combines indirect and downlighting.

With regard to Mr. Long's contribution, the colour question of returned merchandise, especially matching shoes and similar objects, has been one which has been exercising us for some time, and it is felt that with the introduction of the new "natural" coloured lamps this problem has been solved.

The future of store lighting depends on the imagination and ideals of every individual illuminating engineer who comes in contact with the problems, and if this paper has helped to define what these problems are and to create an interest in them, then it has succeeded in its job.

I would like to record my thanks to all those who have helped me in the preparation and presentation of this paper.

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**I.E.S. Fellowship**

The following applications for Fellowship of the Society have been accepted:—

R. W. Ames, C. Dykes Brown, J. N. Hull, A. W. Jervis, H. Moss, J. W. Wooley.

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**Register of Lighting Engineers**

The following applications for inclusion on the Register of Lighting Engineers have been accepted:—

J. M. Sandford, G. O. Singleton, J. S. McCulloch, D. Stanley.

# SESSION 1948—1949

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